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Basic Estimated Capital Investment and Operating Costs for Coal Strip Mines

Revision of Information Circular 8661

UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. Bureau of Mines.

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Information Circular 8703

Basic Estimated Capital Investment and Operating Costs for Coal Strip Mines

Revision of Information Circular 8661

By Sidney Katell, E. L. Hemingway, and L. H. Berkshire
Process Evaluation Group, Morgantown, W. Va.

March 3, 1849

UNITED STATES DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe, Secretary

BUREAU OF MINES
Thomas V. Falkie, Director

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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BASIC ESTIMATED CAPITAL INVESTMENT AND OPERATING COSTS FOR COAL STRIP MINES

Revision of Information Circular 8661

by

Sidney Katell,[1] E. L. Hemingway,[2] and L. H. Berkshire[3]

ABSTRACT

This Bureau of Mines study estimates typical capital investments, operating costs, and selling prices for two bituminous coal strip mines in the Eastern and Interior provinces and a subbituminous coal operation in the Northern Great Plains province. The annual productions were based on tonnage required to fuel a 250-million-standard-cubic-foot-per-day, high-Btu gas plant. The annual tonnage for the Eastern province mine is 4.8 million tons; for the Interior province mine, 6.72 million tons; and for the Northern Great Plains province mine, 9.2 million tons. It is assumed that the mines have a 20-year life. Wages and union welfare payments are considered as of December 6, 1974, under the terms of the Bituminous Wage Agreement of 1974, and costs for material and equipment are based on 1975 indexes.

Initial capital investment varies: $65,137,900 for the 4.8-million-ton-per-year (MM tpy) mine in the Eastern province, $78,514,600 for the 6.72-MM-tpy mine in the Interior province, and $42,050,100 for the 9.2-MM-tpy mine in the Northern Great Plains province. Total capital investments for the Eastern province mine, the Interior province mine, and the Northern Great Plains province mine are $86,969,900, $109,378,500, and $78,543,500, respectively. Corresponding selling prices for the coal, per ton, are $6.94, $6.03, and $3.39, assuming a 15-percent discounted cash flow rate of return after Federal income taxes.

These studies are considered typical for the areas involved. Costs will vary depending on specific locations in these areas.

INTRODUCTION

Growing public concern about the increasing demand for energy has brought about a renewed interest in coal production in the United States. Because cost is an important factor in determining the extent to which coal will be used to satisfy this energy requirement, the Bureau of Mines is preparing a series of reports that provide estimated capital investments and operating costs for hypothetical mines that may be used in the production of synthetic fuels or for electric utility plants.

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[1] Chief, Process Evaluation Group (now retired).

[2] Mining engineer.

[3] Economist.

Three studies that presented capital investment and operating costs for coal mines, based on rates which were in effect under the Bituminous Wage Agreement of 1971, were published in 1974.[4] This report is the third of a new series which updates the previous publications to reflect wage and union welfare rates which went into effect December 6, 1974, under the Bituminous Wage Agreement of 1974. It presents a basic study of capital investments and operating costs for three hypothetical strip mines located in the Eastern, Interior, and Northern Great Plains provinces. The annual production for the Eastern province mine is 4.8 million tons; for the Interior province mine, 6.72 million tons; and for the Northern Great Plains province mine, 9.2 million tons. Since costs are affected by many factors, any particular mine, in reality, will have to be considered in relation to its own special situation and requirements.

Annual productions were based on tonnage required to fuel a 250-million-standard-cubic-foot-per-day, high-Btu gas plant. It is assumed that the mines are located adjacent to the plants they fuel.

The mines are assumed to have a 20-year life. Costs for material and equipment are based on 1975 cost indexes. Selling prices are based on a 15-percent discounted cash flow (DCF) rate of return after Federal income taxes considered minimum for this type of operation.

GENERAL MINING DESCRIPTION

To provide more constant tonnage and flexibility of mining, the mining plan for each of the three studies includes two strip mines dumping at a common storage or loading area.

The Eastern province study considers the typical hilly terrain with overburden ranging from zero feet at the outcrop to 100 feet maximum and a 6-foot coalbed. After drilling and blasting, the overburden is removed by 100-cubic-yard shovels. Both the highwall drills and strip shovels will be supported by bulldozers. The coal will be loaded, without shooting, by 15-cubic-yard shovels into 120-ton trucks.

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[4] Katell, S., and E. L. Hemingway. Basic Estimated Capital Investment and Operating Costs for Underground Bituminous Coal Mines: Mines With Annual Production of 1.06 to 4.99 Million Tons From a 72-Inch Coalbed. BuMines IC 8632, 1974, 41 pp.

_____. Basic Estimated Capital Investment and Operating Costs for Underground Bituminous Coal Mines: Mines With Annual Production of 1.03 to 3.09 Million Tons From a 48-Inch Coalbed. BuMines IC 8641, 1974, 31 pp.

_____. Basic Estimated Capital Investment and Operating Costs for Coal Strip Mines. BuMines IC 8661, 1974, 31 pp.

The Interior province study is based on a 6-foot coalbed with an overburden averaging 70 feet, which, after blasting, is removed by 120-cubic-yard electric shovels. The overburden drill and strip shovels are backed up with bulldozers and wheel tractor scrapers. The 20-cubic-yard electric shovels, supported by front-end loaders for cleanup and auxiliary loading, load the coal, without shooting, into 120-ton trucks.

The Northern Great Plains province study is based on a 25-foot seam of coal with an average of 70 feet of overburden. The blasted overburden is removed by 45-cubic-yard draglines. The 15-cubic-yard electric shovels load coal into 120-ton trucks. The coal-loading shovels work with front-end loaders; the drills and draglines are backed up by bulldozers and wheel tractor scrapers.

All shooting will be done with ammonium nitrate-fuel (AN-FO) mixture.

The incoming high voltage will be reduced to 7,200 volts before entering the mine power system. Overburden drills, stripping equipment, coal loading shovels, pumps, and lighting equipment will be operated by electrical power.

Backup equipment for reclamation, road building and maintenance, service, maintenance, and transportation is essentially the same for each of these three studies.

The following equipment list describes the pieces of equipment that will be used in the mines:

	Eastern	Interior	Northern Great Plains
Drill (overburden) Electric, crawler. Hole diameter: 9 to 15 inches. Bit loading: 110,000 lb.	x	x	x
Working on overburden Bulldozer, track-type: 385 flywheel horsepower (fwhp). Wheel tractor scraper: 400 fwhp.	x	x	x
Reclamation and roads Bulldozer, track-type: 385 fwhp. Wheel tractor scraper: 400 fwhp.	x	x	x
Truck (coal) Bottom dump. Capacity: 120 tons. Engine hp: 800.	x	x	x
Working with coal shovel Front-end loader, rubber-tired: 15 cu yd.	x	x	x

	Eastern	Interior	Northern Great Plains
Shovel (coal loading) Electric, crawler. Dipper capacity: 15 cu yd. Dumping height, maximum: 27.25 ft. Dumping radius, maximum: 53 ft.	x		x
Shovel (overburden) Electric, crawler. Dipper capacity: 100 cu yd. Boom length: 150 ft. Dipper handle length, including dipper: 90.5 ft. Dumping height, maximum: 101 ft. Dumping radius, maximum: 150.5 ft.	x		
Shovel (overburden) Electric, crawler. Dipper capacity: 120 cu yd. Boom length: 210 ft. Dipper handle length, including dipper: 137 ft. Dumping height, maximum: 150 ft. Dumping radius, maximum: 218 ft.		x	
Shovel (coal loading) Electric, crawler. Dipper capacity: 20 cu yd. Dumping height, maximum: 31.75 ft. Dumping radius, maximum: 55 ft.		x	
Dragline (overburden) Electric, walker. Dipper capacity: 45 cu yd. Boom length: 267 ft. Dumping radius: 241 ft.			x

Acreages shown in table 1 are necessary to provide the coal requirements to sustain a 20-year mining operation.

TABLE 1. - Acreage necessary to provide coal requirements to sustain a 20-year operation

Location, province	Production, MM tpy	Annual acres required, 90-percent recovery
Eastern..............	4.8	493
Interior.............	6.72	691
Northern Great Plains.	9.2	231

Information supporting the cost figures in this study is included in tables that make up appendixes A, B, and C. The following tables are included for each of the mines:

Table	
1	Capital investment summary
2	Manning table
3	Depreciation schedule
4	Estimated annual operating cost
5	Estimated working capital and total capital investment
6	Summary of discounted cash flow
7	Discounted cash flow analysis

SUMMARY

This report furnishes cost analyses for three hypothetical coal strip mines. A summary of the total capital investments, operating costs, and selling prices is given in table 2.

TABLE 2. - Summary of capital investment, operating costs, and selling price by annual output capacity

MM tons per year and location (province)......	4.8, Eastern	6.72, Interior	9.2, Northern Great Plains
Estimated initial capital investment...............	$65,137,900	$78,514,600	$42,050,100
Estimated deferred capital investment..............	21,832,000	30,863,900	36,493,400
Total.................	86,969,900	109,378,500	78,543,500
Capital investment per ton of production...........	18.12	16.28	8.54
Operating cost per year....	20,992,000	25,696,400	24,027,300
Operating cost per ton of production...............	4.37	3.82	2.61
Selling price per ton, 15 percent DCF[1]............	6.94	6.03	3.39

[1] Discounted cash flow.

Included in table 2 is the cost of reclamation at the various locations. The details of these reclamation costs are shown in table 3.

TABLE 3. - Summary of operating cost attributed to land reclamation

MM tons per year and location (province).....	4.8, Eastern	6.72, Interior	9.2, Northern Great Plains
Direct cost:			
Production..............	$171,600	$257,200	$171,600
Supervision.............	45,100	63,700	38,200
Maintenance.............	95,000	134,100	92,600
Utility.................	17,400	24,600	14,700
Operating supplies......	177,600	201,600	207,000
Contracted for mulching, liming, fertilizing, and seeding...........	192,000	268,800	368,000
Payroll overhead........	131,600	191,800	126,800
Indirect cost............	76,000	102,200	78,600
Fixed cost:			
Taxes and insurance.....	43,100	64,700	64,700
Depreciation............	246,000	369,100	372,000
Total cost...........	1,195,400	1,677,800	1,534,200
Cost per acre, dollars....	2,425	2,428	6,642
Average highwall, feet....	55	70	70
Cost per ton, dollars.....	0.25	0.25	0.17
Annual acres required.....	493	691	231

Selling prices computed at 15-percent DCF rate of return for various seam thicknesses, other than those detailed in the report, are shown in table 4. Equipment modifications are included to meet the annual production rates.

TABLE 4. - Summary of selling prices at 15-percent DCF rate of return for various seam thicknesses

Location, province	Production, MM tons per year	Seam thickness, feet	Selling price, dollars per ton
Eastern..............	2.40	3	11.63
	3.20	4	9.82
	4.00	5	8.09
	4.80	6	6.94
Interior............	3.36	3	10.07
	4.48	4	8.47
	5.60	5	7.01
	6.72	6	6.03
Northern Great Plains............	3.68	10	6.58
	5.52	15	4.86
	9.20	25	3.39
	18.40	50	2.39

APPENDIX A.--EASTERN PROVINCE

TABLE A-1. - Capital investment summary, 4.8-MM-tpy strip mine

	Quantity	Total cost
Stripping shovel	2	$32,256,000
Drill (overburden)	4	2,346,000
Bulldozer (overburden - drill)	2	302,400
Bulldozer (strip shovel)	2	302,400
Cable handler and reel	2	169,000
Coal shovel	2	2,880,000
Front-end loader (with coal shovel)	2	729,400
Truck (coal hauler)	7	2,077,600
Road grader	2	173,600
Wheel tractor scraper (reclamation and roads)	4	1,077,600
Bulldozer (reclamation and roads)	4	604,800
Water truck	1	43,200
Lubrication service truck	1	40,500
Mechanic truck	2	23,400
Welding truck	2	19,200
Electrician truck	2	19,200
Supply truck	1	9,000
Explosive truck	1	24,000
Pickup truck	6	36,000
Forklift	1	8,600
Crane truck	1	115,200
Pump (portable)	4	14,000
Floodlights and towers	-	21,600
Communications	-	16,200
Substation (10,000 kV-A)	4	432,000
Disconnect skid	8	97,200
Breaker skid	8	205,200
Substation (1,000 kV-A)	4	81,000
Substation (150 kV-A)	2	32,400
Connection box	10	16,200
Cable	-	801,900
Explosive storage facilities	-	30,000
Office and washhouse	1	325,000
Shop and warehouse	1	900,000
Oil and fuel storage facilities	-	20,000
Initial road construction	-	125,000
Site preparation	-	75,000
Exploration	-	125,000
Total direct		46,574,800
Field indirect	-	931,500
Total construction		47,506,300

TABLE A-1. - Capital investment summary, 4.8-MM-tpy strip mine - Continued

	Quantity	Total cost
Carried forward		$47,506,300
Engineering	-	950,100
Overhead and administration	-	2,422,800
		50,879,200
Contingency	-	7,631,900
		58,511,100
Fee	-	1,170,200
		59,681,300
Interest during construction - 5 percent	-	2,984,100
Net estimate		62,665,400

TABLE A-2. - Manning table, 4.8-MM-tpy strip mine

Personnel	Total	Wages[1] per day	Cost per year	Cost per ton
Production:				
Shovel operator[2] (overburden).......	6	$55.00	$140,400	
Shovel oiler[2] (overburden)..........	6	50.60	129,400	
Bulldozer operator[2] (overburden)....	6	48.13	123,200	
Driller[3] (overburden)...............	8	48.13	85,800	
Driller helper[3] (overburden)........	8	45.65	81,400	
Bulldozer operator[2] (with drills)...	6	48.13	123,200	
Shooter[3] (overburden)...............	2	48.13	21,200	
Explosive truck operator[3]...........	2	48.13	21,200	
Shovel operator[3] (coal).............	4	55.00	48,900	
Shovel oiler[3] (coal)................	4	50.60	45,100	
Front-end loader[3] (with coal shovel)	4	48.13	42,900	
Pitman[3] (coal)......................	4	45.65	40,700	
Truckdriver[3] (coal).................	12	48.13	128,600	
	72		1,032,000	$0.21
Maintenance:[3]				
Road grader operator................	4	48.13	42,900	
Water truck driver..................	2	45.65	20,400	
Lubrication truck driver............	6	45.65	61,500	
Supply truck driver.................	6	45.65	61,500	
Mechanic............................	18	50.60	204,100	
Electrician.........................	9	50.60	102,000	
Welder..............................	9	50.60	102,000	
	54		594,400	.12
Reclamation and road building:[3]				
Wheel tractor scraper operator......	8	48.13	85,800	
Bulldozer operator..................	8	48.13	85,800	
	16		171,600	.04
Utility:[3]				
Utilityman..........................	12	45.65	122,100	.03
Salary:				
Superintendent......................	1		29,000	
General pit foreman.................	2		40,000	
Pit foreman.........................	6		99,000	
Maintenance superintendent..........	1		22,000	
Maintenance foreman.................	3		50,000	
Mining engineer.....................	1		22,000	
Safety inspector....................	3		43,500	
Office manager......................	1		15,500	
Purchasing agent....................	1		15,500	

See footnotes at end of table.

TABLE A-2. - Manning table, 4.8-MM-tpy strip mine - Continued

Timekeeper	1		11,000	
Bookkeeper	1		11,000	
Warehouseman	3		30,000	
	24		388,500	.08
Total labor and supervision	178		2,308,600	.48

[1] Figures are for the day shift. Differentials for other shifts are reflected in the cost per year.

[2] 345 days per year, 3 shifts stripping.

[3] 220 days per year, 2 shifts loading.

TABLE A-3. - Depreciation schedule, 4.8-MM-tpy strip mine

	Straight-line depreciation, years	Yearly charge, dollars
Stripping shovel	20	1,612,800
Drill (overburden)	10	234,600
Bulldozer (overburden and drill)	10	30,200
Bulldozer (strip shovel)	10	30,200
Cable handler and reel	20	8,500
Coal shovel	20	144,000
Front-end loader (with coal shovel)	5	135,800
Truck (coal hauler)	7	267,100
Road grader	10	14,800
Wheel tractor scraper (reclamation and roads)	5	195,300
Bulldozer (reclamation and roads)	10	60,500
Water truck	10	4,100
Lubrication service truck	10	3,500
Mechanic truck	5	4,000
Welding truck	5	3,200
Electrician truck	5	3,200
Supply truck	5	1,200
Explosive truck	5	4,300
Pickup truck	3	10,800
Forklift	5	1,600
Crane truck	10	10,100
Pump	10	1,400
Floodlights and towers	10	2,200
Communications	10	1,600
Electrical equipment	20	43,200
Cable	5	160,400
Explosive storage facilities	20	1,500
Office and washhouse	20	16,300
Shop and warehouse	20	45,000
Oil and fuel storage facilities	20	1,000
Initial road construction	20	6,300
Site preparation	20	3,800
Exploration	20	6,300
Interim equipment replacement	20	278,000
		3,346,800
Depreciation for field indirect, engineering, overhead and administration, contingency, fee, and interest during construction	20	804,500
Total		[1]4,151,300

[1] $0.86 per ton.

NOTE.--Rubber-tired vehicles reflect depreciation excluding tires, which are shown as an operating expense.

TABLE A-4. - Estimated annual operating cost, 4.8-MM-tpy strip mine

	Annual cost	Cost per ton
Direct cost:		
Production:		
Labor	$1,325,700	$0.27
Supervision	316,500	.07
	1,642,200	.34
Maintenance:		
Labor	594,400	.12
Supervision	72,000	.02
	666,400	.14
Operating supplies:		
Spare parts	912,000	.19
Fuel, oil, and lubrication	528,000	.11
Drill bits	192,000	.04
Tires	288,000	.06
Explosives	1,344,000	.28
Miscellaneous	288,000	.06
	3,552,000	.74
Power	1,248,000	.26
Reclamation (contracted for mulching, liming, fertilizing, and seeding)	192,000	.04
Payroll overhead (40 percent of payroll)	923,400	.19
Union welfare[1]	3,817,500	.80
Royalty	2,400,000	.50
Strip license and bond	326,500	.07
Indirect cost:		
15 percent of labor, maintenance, and supplies	879,100	.18
Fixed cost:		
Taxes and insurance, 2 percent of mine cost	1,193,600	.25
Depreciation	4,151,300	.86
	5,344,900	1.11
Total	20,992,000	4.37

[1] Effective Dec. 6, 1974, under the Bituminous Wage Agreement of 1974.

TABLE A-5. - Estimated working capital and total capital investment, 4.8-MM-tpy strip mine

Estimated working capital:		
Direct labor	3 months	$577,200
Operating supplies	do	888,000
Payroll overhead	do	230,900
Indirect cost	4 months	293,000
Fixed cost	0.5 percent of insurance base	298,400
Spare parts		130,000
Miscellaneous		55,000
Total working capital		2,472,500
Total estimated capital investment:		
Total plant (insurance, tax base)		59,681,300
Interest during construction		2,984,100
Subtotal		62,665,400
Working capital		2,472,500
Estimated initial capital investment		65,137,900
Estimated deferred capital investment		21,832,000
Total capital and deferred investment		[1]86,969,900

[1] This is an average cost of $18.12 per ton of annual production.

TABLE A-6. - Summary of discounted cash flow, 4.8-MM-tpy strip mine

Year	Capital investment	Cash flow	Present worth factor at 15 percent	Present worth, capital investment at 15 percent	Present worth, cash flow value at 15 percent
-1	$26,055,200	$-26,055,200	1.15	$29,963,500	$-29,963,500
0	39,082,700	-39,082,700	1.	39,082,700	-39,082,700
1	278,000	11,709,500	.8696	241,700	10,182,600
2	278,000	11,709,500	.7561	210,200	8,853,600
3	278,000	11,709,500	.6575	182,800	7,699,000
4	278,000	11,709,500	.5718	159,000	6,695,500
5	2,990,300	8,997,200	.4972	1,486,800	4,473,400
6	278,000	11,709,500	.4323	120,200	5,062,000
7	2,355,600	9,631,900	.3759	885,500	3,620,600
8	278,000	11,709,500	.3269	90,900	3,827,800
9	278,000	11,709,500	.2843	79,000	3,329,000
10	6,970,200	5,017,300	.2472	1,723,000	1,240,300
11	278,000	11,709,500	.2149	59,700	2,516,400
12	278,000	11,709,500	.1869	52,000	2,188,500
13	278,000	11,709,500	.1625	45,200	1,902,800
14	2,355,600	9,631,900	.1413	332,800	1,361,000
15	2,990,300	8,997,200	.1229	367,500	1,105,800
16	278,000	11,709,500	.1069	29,700	1,251,700
17	278,000	11,709,500	.0929	25,800	1,087,800
18	278,000	11,709,500	.0808	22,500	946,100
19	278,000	11,709,500	.0703	19,500	823,200
20	-2,461,600	14,449,100	.0611	-150,400	882,800
				75,029,600	3,700

TABLE A-7. - Discounted cash flow analysis, 4.8-MM-tpy strip mine

15 percent - 20 years

R = \$75,029,600 ÷ 6.259[1] = \$11,987,500
less depreciation 4,151,300
Depletion + net profit = 7,836,200

Depletion = 10 percent of sales
Federal income tax = net profit
Depletion + net profit = cash flow - depreciation

Sales = 1.0/0.55 (1/2 operating cost + cash flow - depreciation)
= 1/0.55 (10,496,000 + 7,836,200)

Sales	\$33,331,300
Operating cost	20,992,000
Gross profit	12,339,300
Depletion	3,333,100
Taxable income	9,006,200
Federal income tax	4,503,100
Net profit	4,503,100

Annual cash flow = net profit + depreciation + depletion
= \$4,503,100 + \$4,151,300 + \$3,333,100
= \$11,987,500

Selling price per ton = \$33,331,300 ÷ 4,800,000 = \$6.94

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[1] Uniform series present worth factor.

APPENDIX B.--INTERIOR PROVINCE

TABLE B-1. - Capital investment summary, 6.72-MM-tpy strip mine

	Quantity	Total cost
Stripping shovel	2	$38,880,000
Drill (overburden)	4	2,346,000
Wheel tractor scraper (overburden - drill)	2	538,800
Bulldozer (with strip shovel)	2	302,400
Cable handler and reel	2	169,000
Coal shovel	2	3,456,000
Front-end loader (with coal shovel)	2	729,400
Truck (coal hauler)	11	3,264,800
Road grader	2	173,600
Wheel tractor scraper (reclamation and roads)	6	1,616,400
Bulldozer (reclamation and roads)	6	907,200
Water truck	1	43,200
Lubrication service truck	1	40,500
Mechanic truck	2	23,400
Welding truck	2	19,200
Electrician truck	2	19,200
Supply truck	1	9,000
Explosive truck	2	48,000
Pickup truck	6	36,000
Forklift	1	8,600
Crane truck	1	115,200
Pump (portable)	4	14,000
Floodlights and towers	-	21,600
Communications	-	16,200
Substation (10,000 kV-A)	4	432,000
Disconnect skid	8	97,200
Breaker skid	8	205,200
Substation (1,000 kV-A)	4	81,000
Substation (150 kV-A)	2	32,400
Connection box	15	24,300
Cable	-	972,800
Explosive storage facilities	-	40,000
Office and washhouse	1	325,000
Shop and warehouse	1	900,000
Oil and fuel storage facilities	-	20,000
Initial road construction	-	125,000
Site preparation	-	100,000
Exploration	-	125,000
Total direct		56,277,600
Field indirect	-	1,125,600
Total construction		57,403,200

TABLE B-1. - Capital investment summary, 6.72-MM-tpy strip mine - Continued

	Quantity	Total cost
Carried forward		$57,403,200
Engineering	-	1,148,100
Overhead and administration	-	2,927,600
		61,478,900
Contingency	-	9,221,800
		70,700,700
Fee	-	1,414,000
		72,114,700
Interest during construction, 5 percent	-	3,605,700
Net estimate		75,720,400

TABLE B-2. - Manning table, 6.72-MM-tpy strip mine

Personnel	Total	Wages[1] per day	Cost per year	Cost per ton
Production:				
Shovel operator[2] (overburden)	6	$55.00	$140,400	
Shovel oiler[2] (overburden)	6	50.60	129,400	
Bulldozer operator[2] (overburden)	6	48.13	123,200	
Driller[3] (overburden)	12	48.13	129,500	
Driller helper[3] (overburden)	12	45.65	122,000	
Wheel tractor scraper operator[2] (on overburden with drills)	6	48.13	123,200	
Shooter[3] (overburden)	2	48.13	21,200	
Explosive truck operator[3]	2	48.13	21,200	
Shovel operator[4] (coal)	2	55.00	26,400	
Shovel oiler[4] (coal)	2	50.60	24,300	
Front-end loader operator[4] (with coal shovel)	2	48.13	23,100	
Pitman[4] (coal)	2	45.65	21,900	
Truckdriver[4] (coal)	10	48.13	115,500	
	70		1,021,300	$0.15
Maintenance:[3]				
Road grader operator	4	48.13	42,900	
Water truck driver	2	45.65	20,400	
Lubrication truck driver	6	45.65	61,500	
Supply truck driver	6	45.65	61,500	
Mechanic	18	50.60	204,100	
Electrician	9	50.60	102,000	
Welder	9	50.60	102,000	
	54		594,400	.09
Reclamation and road building:[3]				
Wheel tractor scraper operator	12	48.13	128,600	
Bulldozer operator	12	48.13	128,600	
	24		257,200	.04
Utility:[3]				
Utilityman	12	45.65	122,100	.02
Salary:				
Superintendent	1		29,000	
General pit foreman	2		40,000	
Pit foreman	6		99,000	
Maintenance superintendent	1		22,000	
Maintenance foreman	3		50,000	
Mining engineer	1		22,000	

See footnotes at end of table.

TABLE B-2. - Manning table, 6.72-MM-tpy strip mine - Continued

Safety inspector.................	3		43,500	
Office manager...................	1		15,500	
Purchasing agent.................	1		15,500	
Timekeeper.......................	1		11,000	
Bookkeeper.......................	1		11,000	
Warehouseman.....................	3		30,000	
	24		388,500	.05
Total labor and supervision...	184		2,383,500	.35

[1] Figures are for the day shift. Differentials for other shifts are reflected in the cost per year.
[2] 345 days per year.
[3] 220 days per year.
[4] 240 days per year, 1 shift loading.

TABLE B-3. - Depreciation schedule, 6.72-MM-tpy strip mine

	Straight-line depreciation, years	Yearly charge, dollars
Stripping shovel	20	1,944,000
Drill (overburden)	10	234,600
Wheel tractor scraper (on overburden with drills)	5	97,700
Bulldozer (with strip shovel)	10	30,200
Cable handler and reel	20	8,500
Coal shovel	20	172,800
Front-end loader (with coal shovel)	5	135,800
Truck (coal hauler)	7	419,200
Road grader	10	14,800
Wheel tractor scraper (reclamation and roads)	5	293,100
Bulldozer (reclamation and roads)	10	90,700
Water truck	10	4,100
Lubrication service truck	10	3,500
Mechanic truck	5	4,000
Welding truck	5	3,200
Electrician truck	5	3,200
Supply truck	5	1,200
Explosive truck	5	8,600
Pickup truck	3	10,800
Forklift	5	1,600
Crane truck	10	10,100
Pump	10	1,400
Floodlights and towers	10	2,200
Communications	10	1,600
Electrical equipment	20	43,600
Cable	5	194,600
Explosive storage facilities	20	2,000
Office and washhouse	20	16,300
Shop and warehouse	20	45,000
Oil and fuel storage facilities	20	1,000
Initial road construction	20	6,300
Site preparation	20	5,000
Exploration	20	6,300
Interim equipment replacement	20	420,000
		4,237,000
Depreciation for field indirect, engineering, overhead and administration, contingency, fee, and interest during construction	20	972,100
Total		[1]5,209,100

[1] $0.77 per ton.

NOTE.--Rubber-tired vehicles reflect depreciation excluding tires, which are shown as an operating expense.

TABLE B-4. - Estimated annual operating cost, 6.72-MM-tpy strip mine

	Annual cost	Cost per ton
Direct cost:		
Production:		
Labor	$1,400,600	$0.21
Supervision	316,500	.05
	1,717,100	.26
Maintenance:		
Labor	594,400	.09
Supervision	72,000	.01
	666,400	.10
Operating supplies:		
Spare parts	1,075,200	.16
Fuel, oil, and lubrication	672,000	.10
Drill bits	201,600	.03
Tires	336,000	.05
Explosives	1,411,200	.21
Miscellaneous	336,000	.05
	4,032,000	.60
Power	1,209,600	.18
Reclamation (contracted for mulching, liming, fertilizing, and seeding)	268,800	.04
Payroll overhead (40 percent of payroll)	953,400	.14
Union welfare[1]	5,250,400	.78
Royalty	3,360,000	.50
Strip license and bond	625,000	.09
Indirect cost:		
15 percent of labor, maintenance, and supplies	962,300	.14
Fixed cost:		
Taxes and insurance, 2 percent of mine cost	1,442,300	.22
Depreciation	5,209,100	.77
	6,651,400	.99
Total	25,696,400	3.82

[1] Effective Dec. 6, 1974, under the Bituminous Wage Agreement of 1974.

TABLE B-5. - Estimated working capital and total capital investment, 6.72-MM-tpy strip mine

Estimated working capital:		
Direct labor	3 months	$595,800
Operating supplies	do	1,008,000
Payroll overhead	do	238,400
Indirect cost	4 months	320,800
Fixed cost	0.5 percent of insurance base	360,600
Spare parts		187,600
Miscellaneous		83,000
Total working capital		2,794,200
Total estimated capital investment:		
Total plant (insurance, tax base)		72,114,700
Interest during construction		3,605,700
Subtotal		75,720,400
Working capital		2,794,200
Estimated initial capital investment		78,514,600
Estimated deferred capital investment		30,863,900
Total capital and deferred investment		[1]109,378,500

[1] This is an average cost of $16.28 per ton of annual production.

TABLE B-6. - Summary of discounted cash flow, 6.72-MM-tpy strip mine

Year	Capital investment	Cash flow	Present worth factor at 15 percent	Present worth, capital investment at 15 percent	Present worth, cash flow value at 15 percent
-1	$31,405,800	$-31,405,800	1.15	$36,116,700	$-36,116,700
0	47,108,800	-47,108,800	1.	47,108,800	-47,108,800
1	420,000	14,244,700	.8696	365,200	12,387,200
2	420,000	14,244,700	.7561	317,600	10,770,400
3	420,000	14,244,700	.6575	276,200	9,365,900
4	420,000	14,244,700	.5718	240,200	8,145,100
5	4,404,800	10,259,900	.4972	2,190,100	5,101,200
6	420,000	14,244,700	.4323	181,600	6,158,000
7	3,684,800	10,979,900	.3759	1,385,100	4,127,300
8	420,000	14,244,700	.3269	137,300	4,656,600
9	420,000	14,244,700	.2843	119,400	4,049,800
10	8,384,700	6,280,000	.2472	2,072,700	1,552,400
11	420,000	14,244,700	.2149	90,300	3,061,200
12	420,000	14,244,700	.1869	78,500	2,662,300
13	420,000	14,244,700	.1625	68,300	2,314,800
14	3,684,800	10,979,900	.1413	520,700	1,551,600
15	4,404,800	10,259,900	.1229	541,300	1,260,900
16	420,000	14,244,700	.1069	44,900	1,522,800
17	420,000	14,244,700	.0929	39,000	1,323,300
18	420,000	14,244,700	.0808	33,900	1,151,800
19	420,000	14,244,700	.0703	29,500	1,001,400
20	-2,793,400	17,458,100	.0611	-170,700	1,066,700
				91,786,600	4,400

TABLE B-7. - Discounted cash flow analysis, 6.72-MM-tpy strip mine

15 percent - 20 years

R = $91,786,600 ÷ 6.259[1] = $14,664,700
less depreciation 5,209,100
Depletion + net profit = 9,455,600

Depletion = 10 percent of sales
Federal income tax = net profit
Depletion + net profit = cash flow - depreciation

Sales = 1.0/0.55 (1/2 operating cost + cash flow - depreciation)
= 1/0.55 (12,848,200 + 9,455,600)

Sales	$40,552,400
Operating cost	25,696,400
Gross profit	14,855,000
Depletion	4,055,200
Taxable income	10,800,800
Federal income tax	5,400,400
Net profit	5,400,400

Annual cash flow = net profit + depreciation + depletion
= $5,400,400 + $5,209,100 + $4,055,200
= $14,664,700

Selling price per ton = $40,552,400 ÷ 6,720,000 = $6.03

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[1] Uniform series present worth factor.

APPENDIX C.--NORTHERN GREAT PLAINS PROVINCE

TABLE C-1. - Capital investment summary, 9.2-MM-tpy strip mine

	Quantity	Total cost
Dragline	2	$11,160,000
Bulldozer (with dragline)	4	604,800
Drill (overburden)	2	1,173,000
Wheel tractor scraper (with overburden drill)	4	1,077,600
Cable handler and reel	2	169,000
Coal drill	2	70,000
Coal shovel	2	2,880,000
Front-end loader (with coal shovel)	2	729,400
Truck (coal hauler)	15	4,452,000
Road grader	2	173,600
Wheel tractor scraper (reclamation and roads)	6	1,616,400
Bulldozer (reclamation and roads)	6	907,200
Water truck	1	43,200
Lubrication service truck	1	40,500
Mechanic truck	2	23,400
Welding truck	2	19,200
Electrician truck	2	19,200
Supply truck	1	9,000
Explosive truck	2	48,000
Pickup truck	6	36,000
Forklift	1	8,600
Crane truck	1	115,200
Pump (portable)	6	21,000
Floodlights and towers	-	21,600
Communications	-	16,200
Substation (10,000 kV-A)	4	432,000
Disconnect skid	8	97,200
Breaker skid	8	205,200
Substation (1,000 kV-A)	4	81,000
Substation (150 kV-A)	2	32,400
Connection box	15	24,300
Cable	-	980,900
Explosive storage facilities	-	50,000
Office and washhouse	1	325,000
Shop and warehouse	1	1,100,000
Oil and fuel storage facilities	-	30,000
Initial road construction	-	125,000
Site preparation	-	100,000
Exploration	-	150,000
Total direct		29,167,100
Field indirect	-	583,300
Total construction		29,750,400

TABLE C-1. - Capital investment summary, 9.2-MM-tpy strip mine - Continued

	Quantity	Total cost
Carried forward		$29,750,400
Engineering	-	595,000
Overhead and administration	-	1,517,300
		31,862,700
Contingency	-	4,779,400
		36,642,100
Fee	-	732,800
		37,374,900
Interest during construction, 5 percent	-	1,868,700
Net estimate		39,243,600

TABLE C-2. - Manning table, 9.2-MM-tpy strip mine

Personnel	Total	Wages[1] per day	Cost per year	Cost per ton
Production:				
Dragline operator[2] (overburden)	6	$55.00	$140,400	
Dragline oiler[2] (overburden)	6	50.60	129,400	
Bulldozer operator[2] (overburden)	10	48.13	165,800	
Driller[3] (overburden)	4	48.13	42,900	
Driller helper[3] (overburden)	4	45.65	40,700	
Shooter[3] (overburden)	2	48.13	21,200	
Wheel tractor scraper operator[3] (with overburden drill)	8	48.13	85,500	
Driller[3] (coal)	4	48.13	42,900	
Driller helper[3] (coal)	4	45.65	40,700	
Shovel operator[4] (coal)	4	55.00	48,900	
Shovel oiler[4] (coal)	4	50.60	45,100	
Front-end loader operator[4] (with coal shovel)	4	48.13	42,900	
Shooter[4] (coal)	4	48.13	42,900	
Pitman[4] (coal)	4	45.65	40,700	
Truckdriver[4] (explosive truck)	2	48.13	21,200	
Truckdriver[4] (coal)	28	48.13	300,200	
	98		1,251,400	$0.14
Maintenance:[3]				
Road grader operator	4	48.13	42,900	
Water truck driver	2	45.65	20,400	
Lubrication truck driver	6	45.65	61,500	
Supply truck driver	6	45.65	61,500	
Mechanic	18	50.60	204,100	
Electrician	9	50.60	102,000	
Machinist	9	50.60	102,000	
Welder	9	50.60	102,000	
	63		696,400	.08
Reclamation and road building:[3]				
Wheel tractor scraper operator	8	48.13	85,500	
Bulldozer operator	8	48.13	85,500	
	16		171,000	.02
Utility:[3]				
Utilityman	12	45.65	122,100	.01
Salary:				
Superintendent	1		29,000	
General pit foreman	2		40,000	
Pit foreman	6		99,000	
Maintenance superintendent	1		22,000	
Maintenance foreman	3		50,000	
Mining engineer	1		22,000	

See footnotes at end of table.

TABLE C-2. - Manning table, 9.2-MM-tpy strip mine - Continued

Safety inspector................	3		43,500	
Office manager..................	1		15,500	
Purchasing agent................	1		15,500	
Timekeeper......................	1		11,000	
Bookkeeper......................	1		11,000	
Warehouseman....................	3		30,000	
	24		388,500	.04
Total labor and supervision...	213		2,629,400	.29

[1] Figures are for the day shift. Differentials for the other shifts are reflected in the cost per year.

[2] 345 days per year.

[3] 220 days per year.

[4] 240 days per year, 1 shift loading.

TABLE C-3. - Depreciation schedule, 9.2-MM-tpy strip mine

	Straight-line depreciation, years	Yearly charge, dollars
Dragline	20	558,000
Bulldozer (with dragline)	10	60,500
Drill (overburden)	10	117,300
Wheel tractor scraper (with overburden drill)	5	195,400
Coal handler and reed	20	8,500
Coal drill	10	7,000
Shovel (coal)	20	144,000
Front-end loader (with coal shovel)	5	135,800
Truck (coal hauler)	7	572,300
Road grader	10	14,800
Wheel tractor scraper (reclamation and roads)	5	293,100
Bulldozer (reclamation and roads)	10	90,600
Water truck	10	4,100
Lubrication truck	10	3,500
Mechanic truck	5	4,000
Welding truck	5	3,200
Electrician truck	5	3,200
Supply truck	5	1,200
Explosive truck	5	8,600
Pickup truck	3	10,800
Forklift	5	1,600
Crane truck	10	10,100
Pump	10	2,100
Floodlights and towers	10	2,200
Communications	10	1,600
Electrical equipment	20	43,600
Cable	5	196,200
Explosive storage facilities	20	2,500
Office and washhouse	20	16,300
Shop and warehouse	20	55,000
Oil and fuel storage facilities	20	1,500
Initial road construction	20	6,300
Site preparation	20	5,000
Exploration	20	7,500
Interim equipment replacement	20	540,400
		3,127,800
Depreciation for field indirect, engineering, overhead and administration, contingency, fee, and interest during construction	20	503,800
Total		[1]3,631,600

[1] $0.40 per ton.

NOTE.--Rubber-tired vehicles reflect depreciation excluding tires, which are shown as an operating expense.

TABLE C-4. - Estimated annual operating cost, 9.2-MM-tpy strip mine

	Annual cost	Cost per ton
Direct cost:		
Production:		
Labor	$1,544,500	$0.17
Supervision	316,500	.03
	1,861,000	.20
Maintenance:		
Labor	696,400	.08
Supervision	72,000	.01
	768,400	.09
Operating supplies:		
Spare parts	460,000	.05
Fuel, oil, and lubrication	1,196,000	.13
Drill bits	276,000	.03
Tires	552,000	.06
Explosives	1,196,000	.13
Miscellaneous	460,000	.05
	4,140,000	.45
Power	1,104,000	.12
Reclamation (contracted for mulching, liming, fertilizing, and seeding)	368,000	.04
Payroll overhead (40 percent of payroll)	1,051,800	.11
Union welfare[1]	7,123,600	.77
Royalty, strip license, and rent	2,216,000	.24
Indirect cost:		
15 percent of labor, maintenance, and supplies	1,015,400	.11
Fixed cost:		
Taxes and insurance, 2 percent of mine cost	747,500	.08
Depreciation	3,631,600	.40
	4,379,100	.48
Total	24,027,300	2.61

[1] Effective Dec. 6, 1974, under the Bituminous Wage Agreement of 1974.

TABLE C-5. - Estimated working capital and total capital investment, 9.2-MM-tpy strip mine

Estimated working capital:		
Direct labor	3 months	$657,400
Operating supplies	do	1,035,000
Payroll overhead	do	263,000
Indirect cost	4 months	338,500
Fixed cost	0.5 percent of insurance base	186,900
Spare parts		226,700
Miscellaneous		99,000
Total working capital		2,806,500
Total estimated capital investment:		
Total plant (insurance, tax base)		37,374,900
Interest during construction		1,868,700
Subtotal		39,243,600
Working capital		2,806,500
Estimated initial capital investment		42,050,100
Estimated deferred capital investment		36,493,400
Total capital and deferred investment		[1]78,543,500

[1] This is an average cost of $8.54 per ton of annual production.

TABLE C-6. - Summary of discounted cash flow, 9.2-MM-tpy strip mine

Year	Capital investment	Cash flow	Present worth factor at 15 percent	Present worth, capital investment at 15 percent	Present worth, cash flow value at 15 percent
-1	$16,820,000	$-16,820,000	1.15	$19,343,000	$-19,343,000
2	25,230,100	-25.230,100	1.	25,230,100	-25,230,100
1	540,400	8,210,200	.8696	469,900	7,139,600
2	540,400	8,210,200	.7561	408,600	6,207,700
3	540,400	8,210,200	.6575	355,300	5,398,200
4	540,400	8,210,200	.5718	309,000	4,694,600
5	5,072,100	3,678,500	.4972	2,521,800	1,829,000
6	540,400	8,210,200	.4323	233,600	3,549,300
7	4,992,400	3,758,200	.3759	1,876,600	1,412,700
8	540,400	8,210,200	.3269	176,700	2,683,900
9	540,400	8,210,200	.2843	153,600	2,334,200
10	8,258,400	492,200	.2472	2,041,500	121,700
11	540,400	8,210,200	.2149	116,100	1,764,400
12	540,400	8,210,200	.1869	101,000	1,534,500
13	540,400	8,210,200	.1625	87,800	1,334,200
14	4,992,400	3,758,200	.1413	705,400	531,000
15	5,072,100	3,678,500	.1229	623,400	452,100
16	540,400	8,210,200	.1069	57,800	877,700
17	540,400	8,210,200	.0929	50,200	762,700
18	540,400	8,210,200	.0808	43,700	663,400
19	540,400	8,210,200	.0703	38,000	577,200
20	-2,838,400	11,589,000	.0611	-173,400	708,100
				54,769,700	3,100

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TABLE C-7. - Discounted cash flow analysis, 9.2-MM-tpy strip mine

15 percent - 20 years

R = \$54,769,700 ÷ 6.259[1] = \$8,750,600
less depreciation 3,631,600
Depletion + net profit = 5,119,000

Depletion = 10 percent of sales
Federal income tax = net profit
Depletion + net profit = cash flow - depreciation

Sales = 1.0/0.55 (1/2 operating cost + cash flow - depreciation)
= 1/0.55 (12,013,650 + 5,119,000)

Sales..................	\$31,150,300
Operating cost..........	24,027,300
Gross profit...........	7,123,000
Depletion..............	3,115,000
Taxable income..........	4,008,000
Federal income tax......	2,004,000
Net profit.............	2,004,000

Annual cash flow = net profit + depreciation + depletion
= \$2,004,000 + \$3,115,000 + \$3,631,600
= \$8,750,600

Selling price per ton = \$31,150,300 ÷ 9,200,000 = \$3.39

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[1] Uniform series present worth factor.

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